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UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Marketing Service
Grain Division

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AUG 16 1963

CURRENT SERIAL RECORDS

COMPARISON OF VARIOUS MOISTURE METERS
WITH THE OVEN METHOD IN
DETERMINING MOISTURE CONTENT OF GRAIN

COMPARISON OF VARIOUS MOISTURE METERS WITH THE OVEN
METHOD IN DETERMINING MOISTURE CONTENT OF GRAIN

Prepared by
Standardization and Testing Branch
Grain Division

Each year, the Standardization and Testing Branch of the Grain Division, AMS, at Beltsville, Maryland, receives samples of grain from all field offices of the Division's Inspection Branch for use in evaluating moisture meters and establishing accurate conversion charts based on the oven method (Service and Regulatory Announcements No. 147) for determining moisture content in grain.

These samples are selected to represent a cross section of the moisture range in the several grain crops taken at one percent moisture stops. Samples are selected to represent freshly harvested grain, grain in short-term country storage, and grain in storage for longer periods throughout the country.

In this way, samples are obtained which are, it is believed, representative of the entire crop year as well as by geographical areas.

Table 1 shows for each class or subclass of grain the comparisons based on five-year averages (1957-1961) between three moisture meters as to their moisture value deviations from those of the oven method in terms of:

1. The range.
2. The average.
3. The number showing a plus deviation and the average of these.
4. The number showing a minus deviation and the average of these.

When the sum of the number of plus and minus deviations differs from the total number of samples, the difference is the number that didn't deviate at all. In addition, the total number of samples tested and the range in moisture content of these samples are given. For some years a particular meter may show better performance than in other years. Therefore, five-year average comparisons are used to provide a comprehensive overall evaluation.

When the number of plus deviations and minus deviations are about equal, it is recognized that the best possible conversion chart has been prepared. If, in addition, the average value of these deviations is low, the meter will yield values close to those obtained by the oven method.

A low average deviation is a true measure of the accuracy of the meter, provided that the averages of the plus and minus deviations are not high and also that the range in deviations is not great. In the use of the oven method, duplicate determinations may vary $\pm 0.1\%$ from the average value. Therefore, in comparisons between meters and oven-method moisture values, a variation of 0.2% is considered good agreement.

Although the data presented may show that an instrument used for moisture determination is accurate with respect to the oven method, there may be instances when the moisture values, as determined by a meter, in a particular geographical area will show much greater variations than that given in the table. This is common to all moisture meters because an electrical property related to moisture content is being measured rather than the moisture content itself.

In some areas the meter readings may be lower than the average, while in others they may be higher. Some meters are more sensitive than others to area fluctuations in electrical properties. This sensitivity is reflected in the values for the range in deviation from the oven values shown in the table. When the range is relatively small, any one value is bound to be closer to the average value and, therefore, the average deviation is also smaller.

For official certification purposes, a moisture meter should be able to measure accurately the moisture content of normal grain, as well as grain in such problem areas as:

1. Mixtures of wet and dry grain.
2. Cold grain.
3. Freshly harvested or recently dried grain.
4. High moisture grain.

Over the years, the U. S. Department of Agriculture has evaluated numerous moisture meters in an effort to find one that would be accurate in determining moisture content of normal grain and grain in these problem areas.

In a conductance-type of moisture meter, the grain is pressed between two electrodes connected in series. The conductance of the grain between the electrodes--which in meter B (see tables) are in the form of corrugated steel rolls--is measured when 90 volts of electricity is impressed them. The conductivity is directly related to moisture content under normal conditions, but when the moisture is unevenly distributed in the grain or among the grains, as it is in the problem areas, the path of the electric current is predominantly through the highest moisture concentration.

In the case of the capacitance-type meters, of which meter A and meter C are examples, the capacitance is measured as a whole, so that the wet and drier portions are averaged.

Tables 2, 3, 4, and 5 depict the moisture determination by different moisture meters of mixtures of soybeans at two moisture levels, of corn at two moisture levels, and of ~~freshly~~ harvested soybeans and corn. In the case of the mixtures, the moisture content of the components as determined by each meter is used to compute the expected moisture content and compared with the value actually determined by the meter. For comparative purposes, the moisture content by the oven method is also given.

Meter A is now used in the inspection of grain under the U. S. Grain Standards Act. Meter B was used for this purpose for corn and soybeans until September 1, 1962, and for all other grains until May 1, 1963.

Table 1.--Comparisons based on five-year averages, 1957-61

	Meter A	Meter B	Meter C
<u>EASTERN BARLEY</u>			
No. of samples	379	391	201
Moisture range,%	10.80 to 27.30	10.80 to 27.30	10.80 to 27.30
Range in dev.,%	+1.15 to -.80	+2.31 to -1.88	+1.97 to -2.33
Av. dev. from oven,%	.28	.41	.59
Av. + dev.,% (No.)	.32 (264)	.31 (184)	.33 (148)
Av. - dev.,% (No.)	.23 (108)	.46 (205)	.54 (52)
<u>WESTERN BARLEY</u>			
No. of samples	515	507	161
Moisture range,%	6.05 to 19.82	6.05 to 19.82	6.05 to 19.82
Range in dev.,%	+.70 to -.88	+1.25 to -1.41	+1.51 to 3.54
Av. dev. from oven,%	.26	.41	.54
Av. + dev.,% (No.)	.25 (267)	.30 (196)	.53 (96)
Av. - dev.,% (No.)	.27 (242)	.50 (305)	.54 (64)
<u>CORN</u>			
No. of samples	858	854	576
Moisture range,%	10.80 to 27.30	10.80 to 27.30	10.80 to 27.30
Range in dev.,%	+1.15 to -.80	+2.31 to -1.88	+1.97 to -2.23
Av. dev. from oven,%	.28	.41	.47
Av. + dev.,% (No.)	.32 (533)	.38 (381)	.33 (181)
Av. - dev.,% (No.)	.23 (314)	.53 (466)	.54 (389)
<u>FLAXSEED</u>			
No. of samples	212	225	162
Moisture range,%	4.85 to 13.15	4.85 to 13.15	4.85 to 13.15
Range in dev.,%	+1.00 to -.45	+.77 to -1.00	+.78 to -.26
Av. dev. from oven,%	.24	.23	.48
Av. + dev.,% (No.)	.29 (129)	.21 (88)	.52 (147)
Av. - dev.,% (No.)	.16 (82)	.24 (133)	.11 (14)

Table 1.--Comparisons based on five-year averages, 1957-61 -- Continued

	Meter A	Meter B	Meter C
<u>WESTERN FLAXSEED</u>			
No. of samples	118	119	88
Moisture range,%	3.49 to 6.12	3.49 to 6.12	3.49 to 6.12
Range in dev.,%	+.50 to -.23	+.62 to -.37	+.55 to -.11
Av. dev. from oven,%	.13	.13	.17
Av. + dev.,% (No.)	.15 (66)	.17 (57)	.18 (77)
Av. - dev.,% (No.)	.10 (52)	.12 (59)	.06 (10)
<u>GRAIN SORGHUMS</u>			
No. of samples	356	354	309
Moisture range,%	9.55 to 23.33	9.55 to 23.33	9.55 to 23.33
Range in dev.,%	+1.69 to -.96	+.68 to -2.47	+1.81 to -1.79
Av. dev. from oven,%	.34	.57	.40
Av. + dev.,% (No.)	.39 (236)	.87 (68)	.33 (179)
Av. - dev.,% (No.)	.23 (118)	.65 (285)	.52 (129)
<u>OATS</u>			
No. of samples	484	492	356
Moisture range,%	8.19 to 16.50	8.19 to 16.50	8.19 to 16.50
Range in dev.,%	+1.27 to -.93	+2.42 to -2.05	+1.57 to -2.54
Av. dev. from oven,%	.23	.39	.38
Av. + dev.,% (No.)	.26 (233)	.34 (185)	.42 (281)
Av. - dev.,% (No.)	.21 (232)	.53 (307)	.25 (75)
<u>PUGET SOUND OATS</u>			
No. of samples	79	79	60
Moisture range,%	10.38 to 25.02	10.38 to 25.02	10.38 to 25.02
Range in dev.,%	+2.19 to -.54	+1.35 to -4.17	+2.39 to -1.01
Av. dev. from oven,%	.67	.75	.69
Av. + dev.,% (No.)	.76 (66)	.54 (37)	.80 (44)
Av. - dev.,% (No.)	.25 (12)	.93 (42)	.38 (16)

Table 1.--Comparisons based on five-year
averages, 1957-61 -- Continued

	Meter A	Meter B	Meter C
<u>RYE</u>			
No. of samples	260	260	213
Moisture range, %	9.17 to 16.99	9.17 to 16.99	9.17 to 16.99
Range in dev., %	+.95 to -.62	+1.17 to -1.25	+1.80 to -.96
Av. dev. from oven, %	.25	.27	.31
Av. + dev., % (No.)	.28 (187)	.28 (109)	.31 (92)
Av. - dev., % (No.)	.15 (60)	.27 (147)	.31 (117)
<u>SOYBEANS</u>			
No. of samples	1140	1142	954
Moisture range, %	8.94 to 21.38	8.94 to 21.38	8.94 to 21.38
Range in dev., %	+.79 to -.75	+1.02 to -1.41	+.96 to -1.98
Av. dev. from oven, %	.20	.27	.28
Av. + dev., % (No.)	.20 (469)	.24 (408)	.28 (281)
Av. - dev., % (No.)	.21 (658)	.28 (718)	.30 (654)
<u>DURUM WHEAT</u>			
No. of samples	144	144	79
Moisture range, %	9.13 to 15.88	9.13 to 15.88	9.13 to 15.88
Range in dev., %	+.97 to -.57	+.62 to -1.33	+.06 to -.78
Av. dev. from oven, %	.33	.29	.32
Av. + dev., % (No.)	.35 (131)	.20 (73)	.34 (53)
Av. - dev., % (No.)	.17 (13)	.38 (70)	.28 (26)
<u>EASTERN WHITE WHEAT</u>			
No. of samples	354	355	251
Moisture range, %	11.56 to 16.69	11.56 to 16.69	11.56 to 16.69
Range in dev., %	+1.03 to -1.53	+.55 to -1.65	+1.42 to -.53
Av. dev. from oven, %	.31	.42	.60
Av. + dev., % (No.)	.32 (244)	.21 (42)	.65 (225)
Av. - dev., % (No.)	.20 (105)	.46 (311)	.19 (25)

Table 1.--Comparisons based on five-year averages, 1957-61 -- Continued

	Meter A	Meter B	Meter C
<u>HARD RED SPRING WHEAT</u>			
No. of samples	338	341	174
Moisture range, %	8.10 to 16.64	8.10 to 16.64	8.10 to 16.64
Range in dev., %	+1.14 to -.88	+1.10 to -1.08	+1.23 to -2.62
Av. dev. from oven, %	.27	.30	.35
Av. + dev., % (No.)	.28 (211)	.29 (148)	.34 (113)
Av. - dev., % (No.)	.27 (122)	.32 (187)	.36 (58)
<u>HARD RED WINTER WHEAT</u>			
No. of samples	617	619	428
Moisture range, %	7.11 to 16.96	7.11 to 16.96	7.11 to 16.96
Range in dev., %	+1.37 to -.82	+1.13 to -1.46	+1.70 to -1.52
Av. dev. from oven, %	.28	.32	.56
Av. + dev., % (No.)	.30 (426)	.29 (283)	.62 (366)
Av. - dev., % (No.)	.23 (184)	.35 (327)	.23 (62)
<u>SOFT RED WINTER WHEAT</u>			
No. of samples	843	844	716
Moisture range, %	11.09 to 18.89	11.09 to 18.89	11.09 to 18.89
Range in dev., %	+.75 to -.76	+.74 to -1.43	+1.34 to -2.40
Av. dev. from oven, %	.29	.38	.41
Av. + dev., % (No.)	.26 (567)	.19 (165)	.46 (586)
Av. - dev., % (No.)	.37 (265)	.51 (665)	.22 (123)
<u>WESTERN WHITE WHEAT</u>			
No. of samples	710	709	333
Moisture range, %	6.97 to 17.80	6.97 to 17.80	6.97 to 17.80
Range in dev., %	+1.25 to -.57	+.74 to -1.50	+1.60 to -.65
Av. dev. from oven, %	.29	.37	.46
Av. + dev., % (No.)	.31 (533)	.19 (147)	.52 (289)
Av. - dev., % (No.)	.19 (170)	.42 (561)	.13 (41)

Table 2.--Comparison of two moisture meters in determining
the moisture content of mixed-moisture grain

MOISTURE %					
Sample no.	Oven method	Meter A		Meter B	
		Determined	Calculated	Determined	Calculated
<u>SOYBEANS</u>					
1	14.71	14.45		14.52	
2	10.55	10.55		10.33	
1 & 2 (1:1)	12.53	12.58	12.50	13.41	12.43
3	14.18	14.32			
4	11.62	11.75		13.75	
3 & 4 (1:1)	12.80	13.06	13.04	11.31	
				13.04	12.53

<u>CORN</u>					
5	18.43	18.40		18.21	
6	14.20	14.53		14.03	
5 & 6 (1:1)	16.34	16.38	16.46	16.87	16.12
7	17.88	17.93		17.77	
8	13.85	14.20		13.71	
7 & 8 (1:1)	16.08	15.99	16.06	16.35	15.74

Table 3.--Comparison of three moisture meters with the official oven method in determining the moisture content of freshly harvested soybeans at several country elevators, October 1957

	Meter A	Meter B	Meter C
No. of samples	51	51	51
Moisture range, %	8.34 to 18.32	8.34 to 18.32	8.34 to 18.32
Range in dev., %	+.90 to -.76	+4.43 to -.55	+1.29 to -3.30
Av. dev., %	.34	.85	.51
Av. + dev., %	.36 (34)	1.19 (33)	.48 (27)
Av. - dev., %	.30 (16)	.19 (17)	.55 (24)

Table 4.--Comparison of two moisture meters with the official oven method in determining the moisture content of corn at elevators at a temperature of about 40°F., 1960 crop

	Meter A	Meter B
No. of samples	189	189
Moisture range, %	10.54 to 23.61	10.54 to 23.61
Range in dev., %	+2.15 to -.66	+5.86 to -1.22
Av. dev., %	.53	.89
Av. + dev., %	.58 (160)	1.02 (156)
Av. - dev., %	.22 (27)	.25 (33)

Table 5.--Comparison of two moisture meters with the official oven method in determining the moisture content of freshly harvested soybeans at Easton, Maryland, at a temperature of 41°-53°F., 1960 crop

	Meter A	Meter B
No. of samples	11	11
Moisture range, %	13.02 to 18.43	13.02 to 18.43
Range in dev., %	+.18 to -.87	+.80 to -.75
Av. dev., %	.28	.43
Av. + dev., %	.12	.52
Av. - dev., %	.37	.40



